

Chapter 9 Plate Tectonics

Summary

9.1 Continental Drift

➤ According to Wegener's hypothesis of continental drift, the continents had once been joined to form a single supercontinent.

- He called this supercontinent **Pangaea**, meaning *all land*.
- Wegener believed that about 200 million years ago Pangaea began breaking into smaller continents.

➤ Fossil evidence for continental drift includes several fossil organisms found on different landmasses.

- The distribution of Mesosaurus fossils supported the argument that South America and Africa had once been joined.

➤ Matching types of rock in several mountain belts that today are separated by oceans provide evidence for continental drift.

➤ Wegener found glacial deposits showing that between 220 million and 300 million years ago, ice sheets covered large areas of the Southern Hemisphere. Deposits of glacial till occurred at latitudes that today have temperate or even tropical climates: southern Africa, South America, India, and Australia.

➤ The main objection to Wegener's hypothesis was that he could not describe a mechanism capable of moving the continents.

- The theory of plate tectonics proved that Wegener was correct.

9.2 Sea-Floor Spreading

➤ Earth's mid-ocean ridge system forms the longest features on Earth's surface. The system winds more than 7,000 kilometers through all the major ocean basins like the seam on a baseball.

- **Sonar**, which stands for **s**ound **n**avigation and **r**anging, is a system that uses sound waves to calculate the distance to an object.
- As scientists mapped the ocean floor using sonar, they found long, curved valleys along the edges of some ocean basins called **deep-ocean trenches**.
- The **mid-ocean ridge** is a long chain of mountains extending the length of the ocean.
- A **rift valley** is a deep, central valley that runs down the center of a ridge.

➤ In the process of sea-floor spreading, new ocean floor forms along Earth's mid-ocean ridges, moves slowly outward across ocean basins, and finally sinks back into the mantle beneath deep-ocean trenches.

- In the process of **subduction**, ocean floor returns to the mantle as it sinks beneath a deep-ocean trench.

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➡ Evidence for sea-floor spreading included magnetic stripes in ocean-floor rock, earthquake patterns, and measurements of the ages of ocean floor rocks.

- Earth's magnetic field occasionally reverses polarity. As certain rocks form, they acquire the polarity that Earth's magnetic field has at the time.
- **Paleomagnetism** is the study of changes in Earth's magnetic field, as shown by patterns of magnetism in rocks that have formed over time.

9.3 Theory of Plate Tectonics

➡ In the theory of plate tectonics, Earth's lithospheric plates move slowly relative to each other, driven by convection currents in the mantle.

- The lithosphere is broken into several huge pieces, called plates.
- Deep faults separate the different plates.
- There are three types of plate boundaries. Each plate contains a combination of each of the three types.
- **Divergent boundaries** are found where two of Earth's plates move apart.
- **Convergent boundaries** form where two plates move together.
- **Transform fault boundaries** occur where two plates grind past each other.

➡ Most divergent boundaries are spreading centers located along the crests of mid-ocean ridges. Some spreading centers, however, occur on the continents.

➡ At convergent boundaries, plates collide and interact, producing features including trenches, volcanoes, and mountain ranges.

- A **continental volcanic arc** is a range of volcanic mountains produced in part by the subduction of oceanic lithosphere.
- When two oceanic slabs converge, the resulting volcanic activity can build a chain of islands called a **volcanic island arc**.
- When two pieces of continental lithosphere collide, the two continents eventually merge, creating complex mountains.

➡ At a transform fault boundary, plates grind past each other without destroying the lithosphere.

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9.4 Mechanisms of Plate Motions

➤ **Convection currents in the mantle provide the basic driving forces for plate motions.**

- A **convection current** is the continuous flow that occurs in a fluid because of differences in density.
- The hot, but solid rock of the mantle behaves in a plastic way—that is, it can flow slowly over geologic times.
- The heat sources for mantle convection include energy released by radioactive isotopes in the mantle and heat from the core itself.
- In the process called *whole mantle convection*, rock rises from the lower mantle toward the top of the mantle, then sinks back down. This process takes millions of years.

➤ **The sinking of cold ocean lithosphere directly drives the motions of mantle convection through slab-pull and ridge-push. Some scientists think mantle plumes are involved in the upward flow of rock in the mantle.**

- In **slab-pull**, the force of gravity pulls old ocean lithosphere, which is relatively cold and dense, down into the deep mantle.
- In **ridge push**, the stiff ocean lithosphere slides down the asthenosphere that is elevated near mid-ocean ridges.
- A **mantle plume** is a rising column of hot, solid mantle rock at a hot spot.